SITE-WIDE GROUNDWATER ASSESSMENT REPORT
BOEING FORMER C-6 FACILITY
LOS ANGELES, CALIFORNIA

by

Haley & Aldrich, Inc.
San Diego, California

for

Boeing Realty Corporation
Long Beach, California

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Prepared for

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OCTOBER 31, 2002

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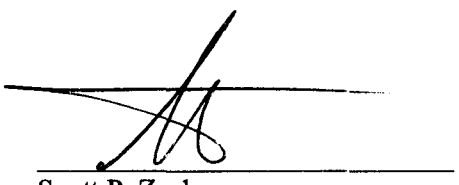

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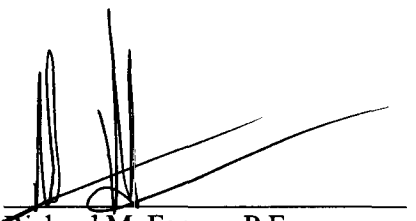

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EXECUTIVE SUMMARY

This report summarizes the results of groundwater assessments conducted at the Boeing Realty Corporation (BRC) Former C-6 Facility (Site). The Site comprises approximately 170 acres in southern Los Angeles, east of the City of Torrance, California. The Site was reportedly farmland prior to 1940 and subsequently was used for aluminum and steel production. In 1952, manufacturing of aircraft and aircraft parts began at the Site and continued through 1992. Adjacent facilities have included Industrial Light Metals (ILM) to the west (a former metals processing facility that operated from around the beginning of World War II until 1992); the former Del Amo facility to the east (a synthetic rubber plant from approximately 1942 to 1972); and Montrose Chemical to the south (a technical grade dichloro-diphenyltrichloroethane (DDT) pesticide manufacturing plant from 1947 to 1982).

BRC is in the process of redeveloping the former aircraft manufacturing facility. Extensive soil and groundwater investigation activities have been completed as well as Site demolition and remediation.

These activities have identified both soil and groundwater impacts. Shallow soil impacts were excavated and remaining soil impacts are being addressed with soil vapor extraction.

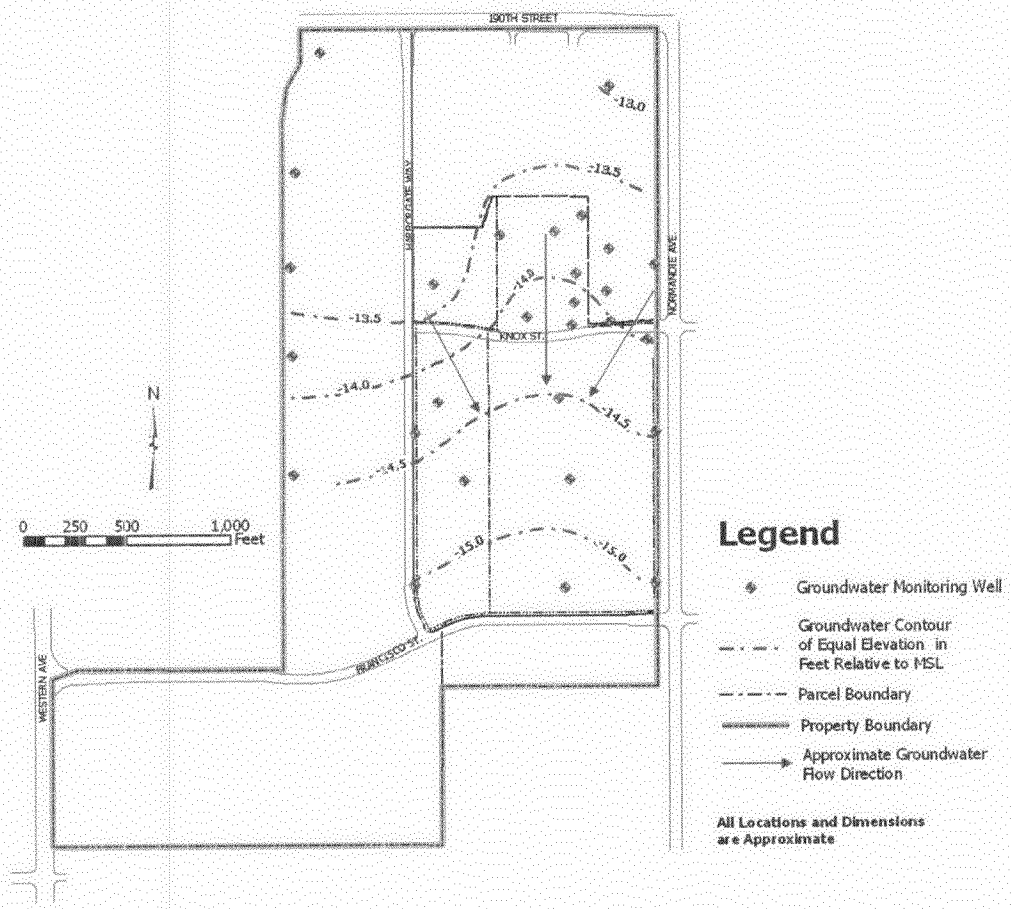
The Site is located on the Torrance Plain within the West Coast Basin of the greater Los Angeles Basin. While water bearing subsurface units extend to depths of up to 1,000 feet or more in the Site vicinity, the major water production zones are at depths of 300 to 500 feet.

The Bellflower Aquitard member of the upper Pleistocene Lakewood Formation is the uppermost water-bearing unit beneath the Site, and extends to about 100 feet below mean sea level (MSL), or approximately 150 feet deep. Three units of the Bellflower Aquitard have been identified which are in descending order: the Upper Bellflower Aquitard (a predominately low-permeable, fine-grained unit), the Middle Bellflower Sand, and the Lower Bellflower Aquitard (a predominately low-permeable, fine-grained unit). The Middle Bellflower Sand is further subdivided into the Middle Bellflower B-Sand, the Middle Bellflower Mud (predominately low-permeability and fine-grained), and the Middle Bellflower C-Sand. The combined Middle Bellflower Sand is on the order of 40 feet thick.

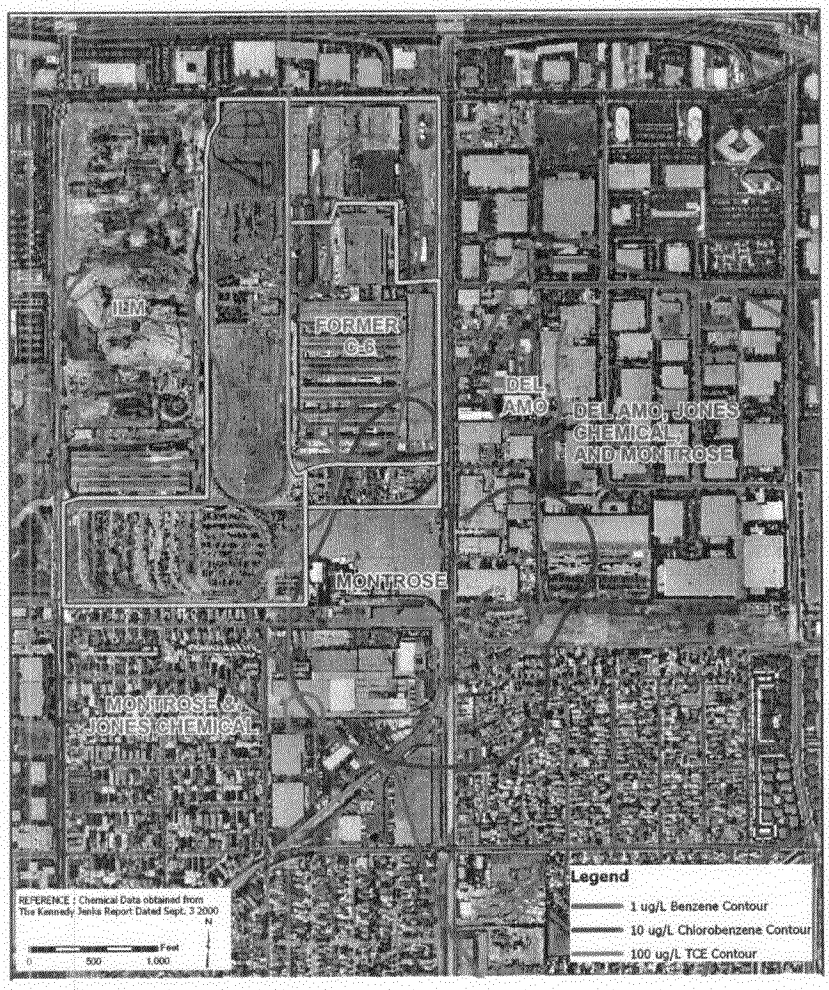
The presence and the direction of groundwater flow have been defined on the basis of water level measurements at monitoring wells. The uppermost, saturated, relatively permeable unit beneath the Site is the Middle Bellflower B-Sand. Groundwater is present at an elevation between approximately 12 to 15 feet below MSL in the B-Sand, which is approximately 65 feet below ground surface (bgs). The piezometric surface of the B-Sand groundwater resembles a shallow trough oriented north south and plunging gently to the south. The hydraulic gradient is approximately 0.001 feet per foot. Water levels in the B-Sand have increased on the order of 8.5 feet at the Site since monitoring was initiated in 1987.

Groundwater flow in the Middle Bellflower B-Sand is principally to the south and the horizontal flow velocity is estimated to range from less than 5 to about 20 feet per year. Groundwater flow in the Middle Bellflower C-Sand is indicated to be south to southwest. The vertical component of groundwater flow in the Middle Bellflower Sand does not appear to be significant, but a slight downward vertical gradient is indicated.

GROUNDWATER ELEVATION CONTOUR (BELLFLOWER) B-SAND - JANUARY 2001



The Site is surrounded by several properties with documented sources and groundwater impacts. These off-site sources of groundwater impacts have also impacted the Site. The primary volatile organic compounds (VOCs) at Del Amo that extend on to the Site are benzene and trichloroethene (TCE). The primary VOCs at Montrose that extend on to the Site are chloroform and chlorobenzene. The primary VOC at ILM that extends on to the Site is TCE.



The chemical quality of groundwater and the water quality impacts in the Bellflower Aquitard beneath the Site have been defined based on groundwater samples collected from monitoring wells and multi-depth (Simulprobe) sampling, including monitored natural attenuation (MNA) parameters. MNA parameters have only been collected from monitoring wells in the upper B-Sand.

TCE was the most prevalent compound detected at the highest concentrations and in the greatest number of locations, therefore, is considered to be the primary VOC at the Site. Four VOCs that were also detected at elevated concentrations in numerous locations are considered the secondary VOCs. These include:

- 1,1-Dichloroethene (1,1-DCE),
- cis-1,2-Dichloroethene (cis-1,2-DCE),
- 1,1,1-Trichloroethane (1,1,1-TCA), and

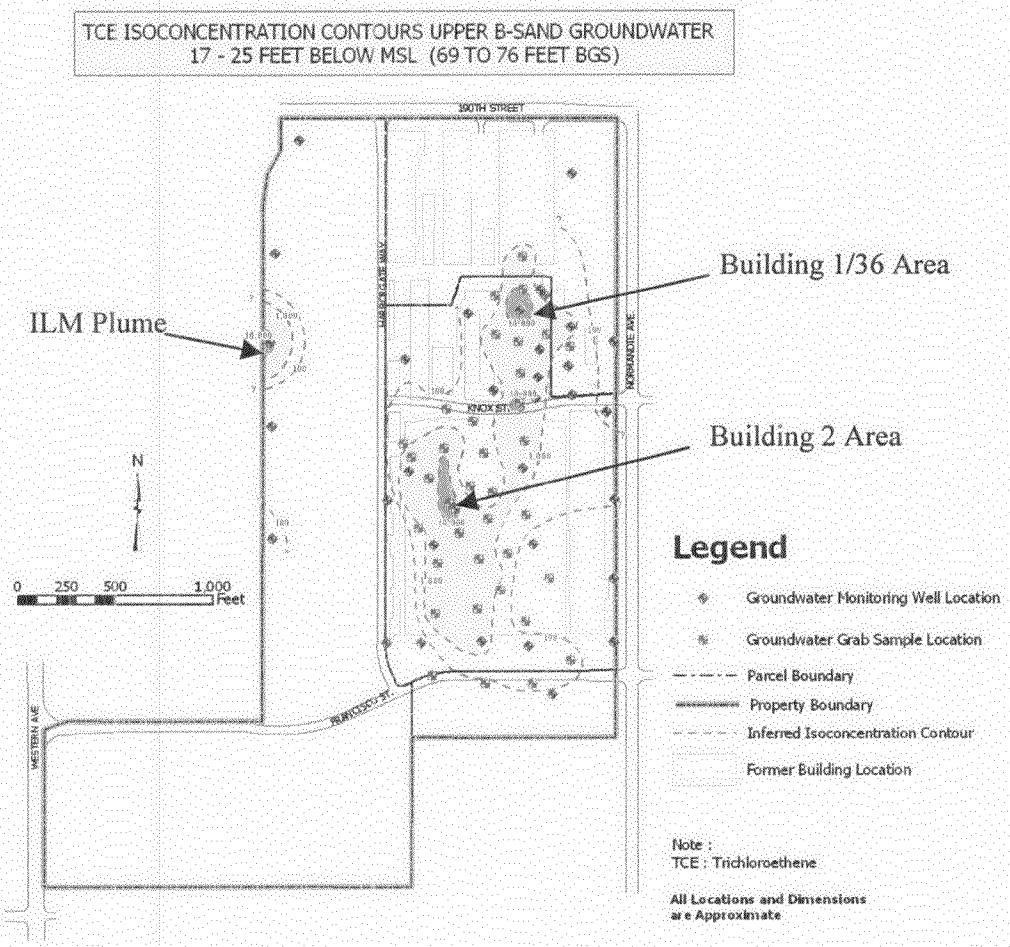
- 2-butanone (or methyl ethyl ketone [MEK]).

Elevated concentrations of primary and secondary VOCs have been identified in two general areas of the Site, the Building 1/36 area and the Building 2 area. The primary suspected source for elevated groundwater impacts in the Building 1/36 plume are soil impacts related to a chemical storage complex located in Building 36 and a series of solvent underground storage tanks (USTs) located between Buildings 1 and 36. The primary suspected source for elevated groundwater impacts in the Building 2 plume are soil impacts related to former metal finishing processes, and releases from one or more wastewater clarifiers.

TCE ISOCONCENTRATION CONTOURS SOIL AT 50 FEET BGS

The primary and secondary VOC concentrations and the extent of groundwater impacts in the Bellflower Aquitard within the Building 1/36 area have been assessed based on groundwater samples from 16 monitoring wells and 15 multi-depth Simulprobe locations. The lateral limits of the plumes in the Building 1/36 area have been delineated. The areas of elevated primary and secondary VOCs are confined to the Site. The overall shape of the plumes in the Building 1/36 area is consistent with the

known soil source areas and the predominant groundwater flow direction to the south. The presence of VOC degradation products (cis-1,2-DCE and 1,1-DCE), depressed readings of dissolved oxygen (DO) (0.20 mg/l), and depressed readings of oxidation reduction potential (ORP) (-187 mV) indicate that bio/chemical transformation of VOCs is occurring in the Building 1/36 plume.



The extent of primary and secondary VOC groundwater impacts in the Bellflower Aquitard within the Building 2 area have been assessed based on groundwater samples from 7 monitoring wells and 29 multi-depth Simulprobe locations. The lateral limits of the plumes in the Building 2 area have been delineated and the areas of elevated primary and secondary VOCs are confined to the Site. One area of elevated TCE concentrations in the Bellflower Aquitard is present along the western Site boundary. These impacts have migrated onto the Site from the ILM facility. The overall shape of the plumes is consistent with the

known soil source areas and predominant groundwater flow directions. Depressed readings of DO and ORP data indicate that biotransformation of VOCs is occurring in the Building 2 plume.

In summary, two general areas of elevated primary and secondary VOC impacts have been identified in groundwater in the Bellflower Aquitard, the Building 1/36 and the Building 2 plumes. The lateral extents of these plumes have been delineated, and the areas of elevated concentrations appear confined to the Site. The observed geometries of the plumes are consistent with the locations of the source areas and the overall horizontal direction of groundwater flow. The vertical distribution of primary and secondary VOCs has been determined within the Middle Bellflower Sand and the general patterns of VOC migration with depth identified. Assessment of the Site-specific hydrogeologic units, direction of groundwater flow, the chemical quality of groundwater, the potential source areas and the extent and magnitude of groundwater impacts beneath the Site has been completed.

1.0 INTRODUCTION

This groundwater assessment report presents the results of the groundwater investigation program undertaken at Boeing Realty Corporation's (BRC's) Former C-6 Facility (Site) in Los Angeles, California (Figure 1). The Site occupies approximately 170 acres (Figure 2) and was used for aircraft manufacturing from 1952 through 1992. BRC is in the process of redeveloping the Site.

This report presents the findings of the comprehensive groundwater assessment conducted at the Site and represents the completion of the groundwater assessment component of the environmental program. This report focuses on the approach, procedures, and results of the groundwater assessment. The Phase II soil investigation component of the environmental program has been addressed in previous reports and is discussed briefly as it relates to the potential source areas associated with groundwater impacts.

1.1 OBJECTIVES

The objectives of the groundwater assessment program were to:

- Review and summarize available regional and Site-specific groundwater data;
- Define the nature and extent of groundwater impacts; and
- Provide a basis for the Site groundwater monitoring and remediation program.

1.2 BACKGROUND

1.2.1 Site Description

The Site is located at 19503 South Normandie Avenue in Los Angeles, California (Figures 1 and 2). The Site occupies approximately 170 acres and is bounded by the following major street and properties:

- 190th Street to the north;
- Normandie Avenue and the Del Amo Superfund Site to the east;
- Montrose Chemical Superfund Site (Montrose), Jones Chemical, and Stauffer Chemical to the south; and
- International Light Metals (ILM) to the west.

For redevelopment purposes, the Site was divided into four parcels, A, B, C, and D (Figure 2). Currently, various stages of redevelopment are underway in parcels A, B, and D. Parcel C is currently vacant and is undergoing infrastructure installation in preparation for new building construction.

1.2.2 History of Site Operations

The Site was first developed by the Defense Plant Corporation in 1941 as part of an aluminum production plant and was operated by the Aluminum Corporation of America until late 1944 (Camp, Dresser & McKee [CDM], 1991). Aerial photographs indicate that the Site was farmland prior to the 1940s. From 1944 until 1948, the Site was used for warehousing by the United States War Assets Administration (USWAA). In 1948, the Columbia Steel Company acquired the Site. In March 1952, the U.S. Navy purchased the Site and established Douglas Aircraft Company (DAC) as the contractor and operator of the Site for the manufacture of aircraft and aircraft parts. DAC purchased the Facility from the Navy in 1970 (CDM, 1991). DAC and its successor, McDonnell Douglas Corporation (created by the 1967 merger of DAC and McDonnell Aircraft Company), owned and operated the Site and continued manufacturing aircraft components until 1992. The Boeing Company took ownership of the Site in 1997 when it merged with McDonnell Douglas Corporation.

Although most manufacturing operations ceased in 1992, a limited amount of assembly and warehousing continued through the mid-1990s. The Site is currently closed and the buildings have been demolished.

Numerous phases of subsurface soil and groundwater investigations related to former Site operations have been conducted at the Site since the mid-1980s. Groundwater investigation activities at the Site began in 1987. Since then, a total of 43 groundwater monitoring wells have been installed at the Site (Table 2). Thirteen wells have been abandoned due to redevelopment activities. Prefixes of Site groundwater monitoring wells include BL, DAC, WCC, TMW, and XMW (Figure 3). WCC wells were drilled between 1987 and 1992 and have been regularly sampled, some as many as 37 times. TMW wells were installed in mid-1998 and early 1999 and have been monitored two to nine times. BL wells were installed in early 1999, as a cooperative effort between Boeing and Lockheed, and were monitored three to six times. XMW wells were installed to monitor the groundwater plume from Montrose, and were monitored up to two times by BRC. All environmental work on the Site has been performed under a cooperative agreement between BRC and the California Regional Water Quality Control Board – Los Angeles Region (LARWQCB).

1.2.3 History of Site Vicinity Operations

There are several industrial facilities in the Site vicinity that are reported to have long-term groundwater investigations:

- ILM;
- Montrose Chemical;
- Del Amo; and
- Other Del Amo Study Area facilities (smaller facilities in the area).

ILM is located immediately to the west of the Site and is approximately 67 acres in size. ILM was a former industrial metals processing facility that operated from approximately the beginning of World War II until 1992. The facility was closed and decommissioned and the property is currently being redeveloped. The former facility operated under a RCRA Part-A permit and a Department of Toxic Substance and Control (DTSC) Hazardous Waste Facility permit (Kennedy Jenks Consultants [KJC], 2000). The California DTSC is the oversight regulatory agency for soil and groundwater investigations at the former ILM facility.

Montrose is located immediately adjacent to the south of the Site and is approximately 13 acres in size. Montrose operated an industrial grade dichloro-diphenyltrichoroethane (DDT) pesticide manufacturing plant from 1947 to 1982. DDT was used in the United States until 1972 when it was banned. Montrose continued processing DDT for export after 1972. The plant discontinued operations in 1982 to 1983 and the buildings were demolished. Since 1985, the facility has been vacant (KJC, 2000). The United States Environmental Protection Agency (US EPA) is the oversight regulatory agency for the soil and groundwater investigations at Montrose.

The Del Amo facility is located across Normandie Avenue to the east of the Site and is approximately 270 acres in size. This facility was a synthetic rubber plant formerly owned and operated by the USWAA, Shell Oil Company (Shell), and Dow Chemical Company (Dow) beginning in 1942. Operations ceased in 1972 and the buildings were demolished. The facility has since been redeveloped, with the exception of the area along the south central property boundary known as the "Del Amo Waste Pits". The US EPA performs oversight of the waste pit area (KJC, 2000).

Other facilities in the Site vicinity include Stauffer Chemical and Jones Chemical, Inc. Stauffer Chemical operated a chemical plant on the Montrose facility. This plant manufactured benzene hexachloride (BHC), a pesticide. Jones Chemical, Inc. is located south of the Montrose facility and manufactures bleach and sells other chemicals in bulk. Jones Chemical, Inc. has been operating since the mid-1950s (KJC, 2000). The US EPA is the oversight regulatory agency for the former Stauffer Chemical and Jones Chemical, Inc. facilities.

2.0 REGIONAL SETTING

2.1 Physiography

The Site is located on the Torrance Plain physiographic area of the West Coast Basin (Figure 4). The Torrance Plain is a relatively broad, featureless area, slightly dissected by local streams and channels. It is bounded to the south by the Palos Verde Hills, to the west by the El Segundo Sand Hills, to the north by the Ballona Gap, and to the east by the Rosecrans and Dominguez hills (California Department of Water Resources [CDWR], 1961). The elevation of the Site is approximately 50 feet above mean sea level (MSL). Regional topography is generally flat with an eastward ground surface slope of approximately 20 feet per mile (less than 0.5 percent). Surface drainage is generally toward the Dominguez Channel, approximately 1 mile to the east, which flows southeastward toward the Los Angeles and Long Beach harbors in San Pedro Bay.

2.2 Regional Geology and Hydrogeology

The principal hydrogeological units in the Site vicinity are the Lakewood Formation and San Pedro Formation. A summary of regional geologic formations is shown in the table below:

Formation	Hydrostratigraphic Unit	
Lakewood Formation (Upper Pleistocene)	Bellflower Aquitard	Upper Bellflower Aquitard (UBA)
		Middle Bellflower Sand (MBFB, MBFM, MBFC, MBFB/C)
		Lower Bellflower Aquitard (LBF)
	Gage Aquifer	
San Pedro Formation (Lower Pleistocene)	Gage Lynwood Aquitard (GLA)	
	Lynwood Aquifer (LYNWOOD)	
	Unnamed Aquitard	
	Silverado Aquifer	

2.2.1 Lakewood Formation

The Lakewood Formation includes the upper Pleistocene sediments in the Los Angeles Coastal Plain area, which in the Site area would include the Semi-Perched aquifer, the Bellflower aquitard, and the

Gage aquifer which are described below (CDWR, 1961). Figure 5 illustrates a generalized stratigraphic cross-section of the Site.

- *Semi-Perched Aquifer* – Shallow, unconfined, and semi-perched aquifer water that is typically found in unconsolidated Quaternary sediments less than 100 feet below ground surface (bgs) (CDWR, 1961, TRC, 1999).
- *Bellflower aquitard* - A heterogeneous mixture of continental, marine, and wind-blown sediments, mainly consisting of clays with sandy and gravelly lenses. The base of the Bellflower aquitard is about 100 feet below MSL (about 150 feet bgs) in the Site area.
- *Gage aquifer* - A water-bearing zone of fine to medium sand and gravel confined by the Bellflower aquitard. It is reported to be approximately 40 feet thick in the Site area.

2.2.2 San Pedro Formation

The Lakewood Formation is underlain by the Lower Pleistocene San Pedro Formation, which extends to approximately 1,000 feet bgs in the Site area. Major water-bearing zones within the San Pedro Formation are the Lynwood aquifer and the Silverado aquifer. These are reported to be at approximately 300 and 500 feet bgs, respectively, in the Site area (CDWR, 1961).

2.3 Local Geology and Hydrogeology

The hydrogeology at the Site has been defined on the basis of data derived from monitoring well drilling, construction, testing and sampling; exploration boring drilling and sampling; cone penetrometer testing; and Simulprobe boring and sampling (Figure 6). Logs for the exploration borings, Simulprobe borings, and groundwater monitoring wells installed at the Site are attached in Appendix A.

2.3.1 Hydrogeologic Units

A Semi-Perched Aquifer is reported to be present in the vicinity of the Site (CDWR, 1961); however, based on correlation of Site stratigraphic data with the data from adjacent Sites, it appears that the Semi-Perched aquifer is absent at the Site.

The hydrogeologic units assessed at the Site are members of the Upper Pliestocene, Lakewood Formation and are identified in descending order as:

- Upper Bellflower Aquitard (UBF),
- Middle Bellflower Sand (MBF), and
- Lower Bellflower Aquitard (LBF).

The lithology, general elevation, thickness and lateral extent of the Site-specific hydrogeologic units have been principally defined based on exploration borings and cone penetrometer testing. This information has been supplemented by data generated during the drilling and construction of monitoring wells and during Simulprobe sampling to provide a Site-wide assessment.

Exploration borings CPT-1-1, CPT-1-2, CPT-2-1, and CPT-2-2 (Figure 6) provided the primary basis for assessing the nature and extent of the hydrogeologic units beneath the Site. These borings were geotechnically logged and continuous soil sampling and logging was conducted at each location in the depth interval from 60 to approximately 120 feet or more. Boring logs are included in Appendix A. Geologic cross sections were constructed using CPT logs as well as other Site geologic data which illustrate the hydrogeologic units across the Site (Figures 7 and 8).

2.3.1.1 Upper Bellflower Aquitard (UBF)

The Upper Bellflower Aquitard (UBF) is predominately a fine-grained hydrogeologic unit. The UBF is a heterogeneous mixture of low permeability silts and clays with fine-grained sands. The UBF unit is continuous beneath the Site. Geologic cross sections (Figures 7 and 8) show that the UBF extends downward from the land surface to an elevation of approximately 14 to 25 feet below MSL.

The UBF generally occurs above the water table at the Site, and therefore all but the lowermost UBF is unsaturated. The UBF makes up the vadose zone at the Site and as a result, hydraulic properties of the UBF have not been estimated.

2.3.1.2 Middle Bellflower Sand (MBF)

The Middle Bellflower Sand (MBF) is a heterogeneous unit primarily comprised of fine to medium sand underlying the UBF. The MBF is continuous beneath the Site (Figures 7 and 8). A notable fine-grained sub-unit divides the MBF into two sands locally beneath the Site. In general, the MBF is the uppermost-saturated, relatively permeable unit beneath the Site.

The Middle Bellflower Sand has been further divided locally to include:

- the Middle Bellflower B-Sand (MBFB),
- the Middle Bellflower Mud (MBFM), and
- the Middle Bellflower C-Sand (MBFC).

2.3.1.2.1 Middle Bellflower B-Sand

The Middle Bellflower B-Sand (B-Sand or MBFB) consists principally of fine to medium grained sand and silty sand with lessor silts and clays. The B-Sand is continuous beneath the Site with an indicated thickness on the order of 25 to 30 feet (Figures 7 and 8). The thickness of the MBFB may range up to

approximately 40 feet locally where the Middle Bellflower Mud is absent and the B-Sand has merged with the Middle Bellflower C-Sand. The top of the B-Sand coincides with the base elevation of the UBF and the elevation of the bottom of the B-Sand is indicated to range from about 35 to 50 feet below MSL where the Middle Bellflower Mud is present.

Upper and lower zones of the B-Sand have been defined for the purpose of further defining the vertical distribution of groundwater quality. The upper B-Sand has been defined in the elevation range between 17 and 25 feet below MSL and the lower B-Sand has been defined in the elevation range between 31 and 46 feet below MSL.

Hydraulic properties of the B-Sand have been estimated from six slug tests performed by Woodward-Clyde Consultants (WCC), one pumping test conducted at monitoring wells by WCC, and water injection tests performed by Arcadis G&M on a series of small-diameter bioenhancement points. Estimates of B-Sand hydraulic conductivity derived from slug test data have been reported to range from 24 to 140 gallons per day per square foot (gpd/ft^2). Estimates of hydraulic conductivity derived from the pumping test data were reported to range from 460 to 970 gpd/ft^2. The storage coefficient was reported to range from 0.004 to 0.0013 (KJC, 2000 and Woodward-Clyde Consultants, 1990). Estimates of hydraulic conductivity from the water injection test was reported to be between 77 to 120 gpd/ft^2 (0.00367 to 0.00577 centimeters per second [cm/sec]) (Arcadis G&M, 2002; Appendix B). Based on the results of these tests, the hydraulic conductivities derived by the slug tests and water injection tests correlate well and range from 24 to 140 gpd/ft^2. Hydraulic conductivity values derived from the pumping test were considerably higher and range from 460 to 970 gpd/ft^2. Since these tests were performed in different wells at different locations of the Site, correlation of the data is difficult.

2.3.1.2.2 Middle Bellflower Mud (MBFM)

The Middle Bellflower Mud (MBFM) is low permeability, heterogeneous and consists predominately of silts and clays with subordinate percentages of sand. Thickness of the MBFM ranges from about three feet at exploration borings CPT-2-1 and CPT-2-2 up to about 13 feet at exploration boring CPT-1-2. The elevation of the top of the MBFM coincides with the bottom elevation of the B-Sand and the base of MBFM is indicated to range from about 45 to 55 feet below MSL (Figures 7 and 8). Hydraulic properties specific to the MBFM have not been determined at the Site.

2.3.1.2.3 Middle Bellflower C-Sand (MBFC).

The lowermost sands of the Middle Bellflower Sand where the MBFM are present have been defined as the Middle Bellflower C-Sand (C-Sand or MBFC). Similar in lithology to the B-Sand, the C-Sand consists principally of fine to medium grained sand and silty sand with lessor silts and clays. The C-Sand is generally continuous beneath the Site, but is apparently merged with the overlying Middle Bellflower B-Sand where the Middle Bellflower Mud is absent. The thickness of the C-Sand ranges from 13 to 21 feet in the Site exploration borings. The top elevation of the C-Sand is equivalent to the

base of the Middle Bellflower Mud and the bottom of the C-Sand is indicated to range from 66 to 90 feet below MSL (Figures 7 and 8).

Hydraulic properties have not been determined for the C-Sand at the Site. Estimates of hydraulic conductivity are reported for slug tests at on-site, deep, monitoring wells WCC-1D and WCC-3D. However, the hydrostratigraphic data derived from the exploration borings (CPT investigation by Haley & Aldrich, Inc.) indicate that these wells were completed in the Lower Bellflower Aquitard; therefore, the slug test data is not representative of the C-Sand.

2.3.1.3 Lower Bellflower Aquitard (LBF)

The Lower Bellflower Aquitard (LBF) is predominately a low-permeability, fine-grained unit that underlies the Middle Bellflower Sand. The LBF is heterogeneous and consists primarily of silts and clays with lesser sands. The LBF is indicated to be continuous beneath the Site.

The thickness of the LBF was not evaluated with Site exploration borings. Exploration boring CPT-1-2 was advanced approximately 9 feet into the LBF. Data from assessments in the vicinity of the Site indicate that the LBF ranges from less than 10 to over 40 feet thick in the area (KJC, 2000 and Dames & Moore, 1998). The top elevation of the LBF coincides with the base of the MBFC. Hydraulic properties for the LBF have not been determined at the Site.

2.3.2 Groundwater Elevations and Gradients

Groundwater management within the West Coast Basin has been under the control of a Watermaster since mid 1940s to minimize impacts from aquifer overpumping and the resulting water quality degradation due to salt-water intrusion and industrial and agricultural activities. All groundwater withdrawals must be approved by the Watermaster. Currently, two active reinjection programs are operating in the basin. The first is the West Coast Basin Barrier wells located just inland of Santa Monica Bay, approximately 6 miles west of the BRC Former C-6 Facility. The second reinjection program is the Dominguez Gap Barrier located in the Wilmington/Carson area along Sepulveda Boulevard, approximately 5 miles south of the Site. Together, these programs have reinjected approximately 20,000 acre-feet per year of imported water back into the basin. This reinjection has caused water levels in the basin to recover approximately 20 feet or more in some areas in the Upper Pleistocene aquifer since their historical lows in the late 1960s. Groundwater elevations in the uppermost groundwater at the Site in January 2001 ranged from approximately 13 to 15 feet below MSL, which is approximately 65 feet bgs.

The presence of groundwater at the Site and its direction of flow have been principally defined on the basis of water level measurements at monitoring wells.

Forty-three monitoring wells have been constructed at the Site. Fourteen of those wells have been subsequently abandoned. The majority of the wells at the Site have been constructed with well screens in the uppermost part of the B-Sand. Two deep monitoring wells (WCC-1D and WCC-3D) were constructed at the Site, which have been abandoned. Stratigraphic data derived from four exploration borings at the Site indicates that those wells have been screened in the LBF.

Water level contours for the uppermost groundwater at the Site are presented in Figure 9, developed from measurements obtained during January 2001. This figure represents current water levels at the Site and serves as the basis for discussing the groundwater elevation and direction of horizontal flow. Groundwater elevations in the uppermost groundwater at the Site in January 2001 ranged from approximately 13 to 15 feet below MSL, which is approximately 65 feet bgs.

Water level measurements have been conducted at the Site since 1987 (Table 3). Water level hydrographs are presented in Appendix C summarizing the elevation of the groundwater surface in each well with respect to time. These figures illustrate historic water levels at the Site and serve as the basis for discussing trends.

2.3.2.1 B-Sand

Currently, there are 29 monitoring wells at the Site completed in the B-Sand. Water level measurements performed during January 2001 at Site monitoring wells provide the basis for defining the occurrence and movement of groundwater in the B-Sand.

During January 2001, groundwater level elevations in the B-Sand ranged from approximately 13 to 15 feet below MSL. Water level elevations were highest in the northern portion of the Site at monitoring well WCC-11S and lowest to the south at TMW-12.

The overall direction of horizontal groundwater flow in the B-Sand beneath the Site is to the south. Groundwater flow in the eastern and western margins of the Site is indicated to be to the south-southwest and south-southeast, respectfully. The overall horizontal hydraulic gradient across the Site is on the order of 0.001 feet per foot.

B-Sand water levels have increased on the order of 8.5 feet since monitoring was initiated during 1987 (Appendix C). This significant increase is attributed to decreases in regional groundwater extraction from the B-Sand as reported by the CDWR (Section 2.4.).

The overall groundwater velocity in the B-Sand across the Site has been estimated based on hydraulic parameters, gradient, and porosity. Assuming a hydraulic conductivity range of 24 to 140 gpd/ft^2 (based on the reported estimates from slug tests), the gradient of 0.001, and an effective porosity of 35 percent, the average horizontal groundwater flow velocity in the MBFB ranges from less than 5 to about 20 feet per year.

2.3.2.2 C-Sand

Currently there are no wells completed in the C-Sand at the Site. However, previously there were two deep monitoring wells (WCC-1D and WCC-3D) completed in the C-Sand or uppermost Lower Bellflower Aquitard or both.

Groundwater level measurements performed at two on-site monitoring wells and data obtained from off-site wells completed in the C-Sand provide the basis for defining the occurrence and movement of water in the C-Sand. Water level measurements conducted in off-site wells and the two deep on-site wells during late 1996 and early 1997 were compiled by KJC (2000) and used to prepare water level elevations for the MBFC (Appendix D).

Groundwater level elevations in the Middle Bellflower C-Sand appear similar overall to the Middle Bellflower B-Sand on-site. Water level elevations for the C-Sand are highest to the north and lowest to the south and the overall horizontal hydraulic gradient is on the order of 0.001 feet per foot.

Water level elevations in the deep monitoring wells on-site increased on the order of 6.5 feet from the time monitoring was initiated during 1989 through January 2001. This indicates that water levels in the Bellflower Aquitard beneath the B-Sand, including the C-Sand, have also increased with time as a probable result of reduced groundwater extractions in the Site vicinity as reported by the CDWR.

A slight downward vertical hydraulic gradient may be present from the Middle Bellflower B-Sand to the underlying portions of the Bellflower Aquitard, including the C-Sand, based on water level measurements in the vicinity of well pairs WCC-1S/WCC-1D and WCC-3S/WCC-3D (Appendix C). The estimated vertical gradient ranges from approximately 0.002 to –0.009 ft./ft. The water level elevations measured in the monitoring wells completed in the B-Sand are slightly higher than those measured at corresponding times in the deep monitoring wells.

2.3.3 Local Groundwater Extraction Wells

Historically, three deep wells were located along the western boundary of Parcel C at the Site (Wells 9, 10, and 11) as shown in Table 1 and on Figure 10 (TRC, 1999). Previously, these wells have been registered with the West Coast Basin Watermaster. The water rights from the three on-site wells were leased by the Douglas Aircraft Corporation from the U.S. Navy on a long-term lease. All three wells were completed at a depth of approximately 600 feet bgs in the Silverado Aquifer, in 1942, by the Aluminum Company of America (ALCOA).

Wells 10 and 11 (named Wells 2 and 3 by BRC) were abandoned in 1998 in accordance with CDWR and Los Angeles County Department of Health Services (LADHS) guidelines (Richard S. Slade [RCS],

1998). Well 9 (named Well 1 by BRC) was abandoned in 2001 in accordance with state and local guidelines (RCS, 2001).

According to the LARWQCB, water in the Bellflower Aquitard is not suitable for supply purposes.

Four Upper Bellflower groundwater remediation extraction wells are located on the Montrose property south of the Site (Figure 10). The wells were installed in 1989. One pump test was conducted in two of the wells in the early 1990s. The wells are currently reportedly used for monitoring and may be used for remediation purposes in the future (Hargis & Associates, 2002).

2.3.4 *Local Groundwater Conditions*

The Site is surrounded by several properties with documented sources of groundwater impacts. To the east of Normandie Avenue and to the south of the Site, the Del Amo and Montrose Chemical Superfund Sites have been investigated extensively (Figure 11). Jones Chemical and Stauffer Chemical to the south of the Site and the ILM property to the west of the Site also have known groundwater impacts originating from their respective operations.

The primary compounds present at the Del Amo Site which extend onto the Site are benzene and TCE. Very low to non-detectable concentrations of benzene have been detected at the Site. Figure 11 illustrates the approximate location of these groundwater plumes. The primary compounds present at the ILM Site which extend onto the Site are TCE and hexavalent chromium. Low concentrations of hexavalent chromium have been detected at the Site and elevated concentrations were detected along the eastern and western Site boundaries (Montrose and ILM facilities).

The primary compounds present in groundwater at the Montrose Chemical Site which extend onto the Site are chloroform and chlorobenzene (Figure 11). The highest chloroform concentration (3,100 µg/L) was detected in March 1999 near the southern Site boundary (TMW-12), and immediately north of the Montrose Chemical Site. Chlorobenzene was also detected (160 µg/l) near the southern boundary of the Site (Montrose monitoring well XMW-09) in January 2001. The northerly migration of chloroform apparently occurred when water levels were significantly lower. Based on water level information from hydrographs presented in the annual Water Master Service in the annual *West Coast Basin, Los Angeles County* (CDWR, 1999) water levels during the mid 1940's through the mid 1950's in the upper water bearing zones were up to 40 feet lower than current levels. Lower water level differentials existed in the deeper zones also (Mobil Oil Co #3 well located approximately 1.5 miles west of the Site). The lower water levels combined with the general northeasterly geologic structural trend (CDWR, 1961) could have contributed to a north-northeasterly flow direction during the time when operations at the Montrose facility were at their peak (1945-1975). Therefore, historical releases from the Montrose facility could have migrated in a north to northeastern direction onto the Site.

3.0 METHODS AND PROCEDURES OF INVESTIGATION

This section describes the methods and procedures used in the groundwater assessment conducted at the Site from 1987 to 2002. Data collected from existing groundwater monitoring wells, previous soil investigations, and a source-area groundwater reconnaissance program have been used for the preparation of this assessment report. The following sections give a brief overview of each of these.

3.1 Groundwater Monitoring Wells

A total of 43 groundwater monitoring wells have been installed at the Site. The monitoring wells were reportedly installed in accordance with LARWQCB requirements and are appropriate for assessing Site-wide groundwater quality. Due to Site redevelopment activities, a number of these wells have been abandoned. A total of 27 wells were monitored in January 2001 and provide the basis for this groundwater assessment report.

Groundwater quality samples have been collected from monitoring wells at the Site since 1987. The monitoring wells have been sampled regularly, some as many as 37 times. Laboratory analyses have been conducted for volatile organic compounds (VOCs) by EPA Method 8260B, trace metals, and major ions for samples collected from near the water table in the upper B-Sand. Analyses have included results for both total and dissolved metals in groundwater. See Appendix E for Tables E-1 through E-3 for a compilation of available analytical results from the Site groundwater monitoring wells. Table 3 provides the historical groundwater elevations.

3.2 Soil Investigation Activities

Soil (shallow and deep) and groundwater investigations have been conducted at all of the parcels at the Site and reports have been prepared. The shallow soil for parcels A, B, and D have been closed by the LARWQCB. Reports for the deep soil in parcels A, B, and D have prepared and submitted to the LARWQCB and closure is pending. A Phase II soil investigation was conducted at the Site, primarily for Parcel C, in 2000-2001 by Haley & Aldrich, Inc. (Haley &Aldrich Inc., 2002). The shallow soil was addressed in the March 2002 report by Haley & Aldrich, Inc. (Haley & Aldrich, Inc., 2002). Figure 12 presents TCE isoconcentration contours in soil at 50 feet bgs for the Site. Over 8,000 soil samples have been collected from over 1,500 distinct locations to characterize the extent of VOC impacts, primarily TCE, from ground surface to approximately 65 feet bgs, which is the approximate depth of the water table. Two primary VOC source areas, the Building 1/36 area and the Building 2 area, were identified as noted on Figure 12. Consequently, a large percentage of the soil sampling focused on these areas. A detailed description of the soil impacts is presented in the Soil Investigation, Soil Remediation, and Screening Level Risk Assessment Report (Haley & Aldrich, 2002).

Results of the Phase II soil investigation also indicated that the current groundwater monitoring well network did not accurately represent the lateral and vertical extent of potential VOC impacts in

groundwater based on soil impacts within the former Building 1/36 and Building 2 areas of the Site. As a result, an additional groundwater investigation program was developed and implemented to delineate the lateral and vertical distribution of VOCs beneath the Building 1/36 and Building 2 source areas.

3.3 Groundwater Investigation

A two-step, multi-depth, sampling program was initiated to delineate the horizontal and vertical distribution of VOCs in groundwater beneath the two source areas. The first step was to characterize the geological units at the Site through the advancement of four cone-penetrometer testing (CPT) borings and collection of soil samples for physical description. Once the CPT borings were completed, the groundwater sampling depths were selected to target the geologic units where the VOCs could likely have migrated. One hundred and twenty three (123) depth-discrete groundwater samples were collected using the Simulprobe sampling system (grab-sample technology) from 44 locations (Figure 6).

The source-area groundwater investigation was performed in phases to facilitate data review and investigation location adjustment. A total of four phases were performed to complete the 44 characterization locations. The locations and depths of the Simulprobe samples were reviewed and verbally approved by the LARWQCB in a series of sequential meetings for each phase of work. These meetings and verbal approvals were held on May 16, 2001, June 27, 2001, September 19, 2001, and April 1, 2002.

Fieldwork was performed in accordance with the detailed standard operating procedures (SOP) for Simulprobe sampling (Appendix F). The groundwater samples were collected in laboratory-provided 40-ml volatile organic analysis (VOA) glass vials, and analyzed for VOCs by EPA Method 8260B. Appropriate Quality Assurance/Quality Control (QA/QC) samples, including duplicates and field blanks, were also collected. All samples were submitted under chain-of-custody (COC) procedures to Severn-Trent Laboratories (STL), a California-certified laboratory.

4.0 GROUNDWATER ASSESSMENT RESULTS

4.1 Site Groundwater

The chemical quality of groundwater and the water quality impacts beneath the Site have been defined based on groundwater samples collected from monitoring wells, including monitored natural attenuation (MNA) parameters, and on multi-depth (Simulprobe) sampling.

Analyses for dissolved metals in groundwater samples collected during 2001 (H&A and England Geosystem, 2001) indicate that hexavalent chromium and trace metals including aluminum, barium, chromium, nickel, mercury, molybdenum, selenium and zinc were present at concentrations greater than the laboratory reporting limit in groundwater beneath the Site (Appendix E).

Major ion analyses for groundwater samples collected during 2001 indicate that groundwater is a calcium-chloride to calcium-bicarbonate type (Appendix E). Calcium is the dominant cation in solution and chloride and bicarbonate are the dominant anions.

4.1.1 Site-Wide Primary VOCs

Trichloroethene (TCE) was the most prevalent compound detected at the highest concentrations and in the greatest number of samples. TCE occurred in 36 out of 37 groundwater monitoring wells, or 98%. Elevated TCE concentrations have been identified in the Building 1/36 and the Building 2 source areas at concentrations up to 21,000 µg/l and 13,000 µg/l, respectively. These areas have been the focus of the detailed groundwater assessment at the Site. Based on the distribution and concentrations observed, TCE is considered the primary VOC at the Site.

4.1.2 Site-Wide Secondary VOCs

Four VOCs that were also detected at elevated concentrations in numerous locations are considered the secondary VOCs. These VOCs and the percentage of Site wells they occur in are listed below.

- 1,1-Dichloroethene (1,1-DCE) (73%),
- cis-1,2-Dichloroethene (cis-1,2-DCE) (51%),
- 1,1,1-Trichloroethane (1,1,1-TCA) (43%), and
- 2-Butanone (or Methyl Ethyl Ketone [MEK]) (14%).

The secondary VOCs have generally been detected and are co-located within the primary VOC plumes.

4.1.3 Hexavalent Chromium

Hexavalent chromium was also detected in groundwater monitoring wells (installed for the Former C-6 Facility) up to 0.037 mg/l, based on groundwater samples collected during January and February 2001. Based on the results from the Site wells, hexavalent chromium concentrations were not detected above the California maximum contaminant level (MCL) for total chromium (0.050 mg/l). As a result, hexavalent chromium is not considered to be a primary or secondary compound at the Site. However, two wells installed along the perimeter of the Site (DAC-P1 and XMW-19) to assess the hexavalent chromium plumes originating from the ILM and Montrose facilities were reported to have concentrations of hexavalent chromium in excess of the MCL. The concentration of hexavalent chromium in wells DAC-P1 and XMW-19 are 0.590 and 0.055 mg/l, respectively.

4.2 Building 1/36 Groundwater Plume

The first area of elevated primary and secondary VOCs in groundwater is referred to as the Building 1/36 Area and generally includes Building 36 and the northeast portion of Building 1, and extends south to the northeast portion of Building 2.

4.2.1 Suspected source(s)

The primary suspected source areas for elevated groundwater impacts in the Building 1/36 plume are soil impact areas identified beneath Building 36, the northeast portion of Building 1, and the southeast portion of Building 1. TCE concentrations in soil above the water table (50 feet bgs) are illustrated in Figure 12. The highest concentrations of VOCs in groundwater within the Building 1/36 plume are present in these general areas. These impacts are primarily related to a chemical storage complex located in Building 36 and a series of solvent underground storage tanks (USTs) located between Building 1 and Building 36.

4.2.1.1 Primary and Secondary VOCs

TCE is the primary VOC and has been detected at concentrations up to 97,000 micrograms per kilogram (µg/kg) in soil samples and up to 21,000 µg/l in groundwater samples collected from monitoring wells and the multi-depth sampling program. The secondary VOC identified in the Building 1/36 groundwater plume are 1,1-DCE, 1,1,1-TCA, toluene, and 2-butanone (Tables 4 and 6).

4.2.1.2 Concentrations/Extent of Impact

The primary and secondary VOC concentrations and the extent of groundwater impacts within the Building 1/36 area have been assessed based on groundwater samples from 16 monitoring wells and 41 multi-depth Simulprobe samples. Isoconcentration contours are presented for each of the primary and secondary VOCs identified in the Building 1/36 area illustrating the concentration distributions and the

lateral extent of groundwater impacts for various depths (Figures 13 through 15, 18 through 20, and 22 through 28).

Vertical distributions of primary and secondary VOC concentrations and the vertical extent of groundwater impacts in the Middle Bellflower Sand are illustrated in cross sections and individual isoconcentration contours for the sand zones. The vertical distributions are illustrated for TCE and 1,1-DCE, the primary VOCs in the Building 1/36 area (Figures 16 and 21).

The overall shapes of the primary and secondary VOC plumes appear consistent with the known soil source areas and predominant southerly groundwater flow direction in the Building 1/36 area. The lateral extent of the plumes in the B-Sand have been delineated and the areas of elevated VOCs resulting from historical site activities are currently confined to the Site. One area of elevated TCE concentrations in the Bellflower Aquitard is present along the western Site boundary. These impacts have migrated onto the Site from the ILM facility. The overall lateral extent of the primary and secondary VOC plumes in the C-Sand is significantly smaller than in the B-Sand and at lower concentrations.

TCE

TCE concentrations in the upper B-Sand exceed 10,000 µg/l within two regions of the north to south-oriented Building 1/36 plume (Figure 13). These regions are near monitoring well TMW-2 and multi-depth sampling locations DDS-1-2 and DDS-1-14. The elevated concentration portion of the groundwater plume (with concentrations exceeding 5,000 µg/l) includes the above mentioned regions and sample locations DDS-1-5 and DDS-1-7 and extends for a distance of approximately 800 feet in the direction of groundwater flow (north to south).

TCE concentrations in the lower B-Sand exceed 1,000 µg/l in a region including the vicinity of multi-depth sample locations DDS-1-2 and DDS-1-3 (Figure 14). The region extends from these sample locations in the primary direction of groundwater movement (south) to the vicinity of DDS-1-15. Overall, B-Sand concentrations of TCE in the Building 1/36 plume are less than the upper B-Sand and the lateral extent of elevated TCE is smaller.

Middle Bellflower C-Sand TCE concentrations and the lateral extent of elevated concentrations are significantly less than both the upper and lower B-Sand (Figure 15). TCE was greater than 1,000 µg/l within the vicinity of multi-depth sample locations DDS-1-2 and DDS-1-4. The location of the elevated TCE concentration at DDS-1-4 is dissimilar to both the upper and lower B-Sands and may be attributed to heterogeneous lithologies (such as a pinch-out of the MBFM), or local differences in groundwater flow direction between the sands. Time-series water-level contours (prepared for the Del Amo Study Area east of the Site; Dames & Moore, 1998) indicate that historically the direction of groundwater movement may have been more southeasterly in the C-Sand.

Figure 16 illustrates the vertical distribution of TCE in the Middle Bellflower Sand along a north-south cross section through the Building 1/36 plume. The two areas of TCE concentrations greater than 10,000 µg/l in the upper B-Sand are apparent, as is the general decreasing trend in concentration with depth from the upper B-Sand to the C-Sand. The section shows the extent of elevated TCE in the C-Sand is limited to the immediate vicinity of the source area near the northern portion of Building 1.

Water quality hydrographs indicate that overall, concentrations of TCE have decreased over time in the majority of the wells (Appendix F).

1,1-DCE

1,1-DCE concentrations in the upper B-Sand exceed 10,000 µg/l within an area extending from sample locations DDS-1-2 in the north to DDS-1-14 in the south (Figure 18). The overall distribution and extent of 1,1-DCE in the upper B-Sand is similar to TCE, but concentrations of 1,1-DCE are greater.

1,1-DCE concentrations in the lower B-Sand equal or exceed 1,000 µg/l in a region including the vicinity of multi-depth sample locations DDS-1-2, DDS-1-5, DDS-1-14 and DDS-1-15 and exceed 5,000 µg/l at DDS-1-3 and DDS-1-3 (Figure 19). The region of elevated 1,1-DCE extends in the primary direction of groundwater flow to the south. Overall, lower B-Sand concentrations of 1,1-DCE in the Building 1/36 plume are less than the upper B-Sand and the lateral extent of elevated 1,1-DCE is somewhat smaller.

Middle Bellflower C-Sand 1,1-DCE exceeds 10,000 µg/ at DDS-1-4 (Figure 20). 1,1-DCE was greater than 1,000 µg/l within the vicinity of multi-depth sample locations DDS-1-2, DDS-1-11 and DDS-1-13. The location of the elevated 1,1-DCE concentration at DDS-1-4 is dissimilar to both the upper and lower B-Sands. This trend was observed for TCE, and as discussed above, may be attributed to heterogeneous lithologies, and/or local differences in historical groundwater flow direction between the sands.

Figure 21 illustrates the vertical distribution of 1,1-DCE in the Middle Bellflower Sand along a north-south cross section through the Building 1/36 plume. The area of 1,1-DCE concentrations greater than 10,000 µg/l in the upper B-Sand is apparent, as is the general decreasing trend in concentration with depth from the upper B- to the C-Sand. 1,1,-DCE is generally the result of the abiotic degradation of 1,1,1-TCA.

1,1,1-TCA

1,1,1-TCA concentrations in the upper B-Sand exceed 5,000 µg/l at sample location DDS-1-2 (Figure 22). 1,1,1-TCA exceeded 1,000 µg/l at TMW-2, WCC-3S and DDS-1-14. A 1,1,1-TCA plume,

extending north-to-south and including the regions of elevated 1,1,1-TCA, is defined by the 100 µg/l concentration contour. The Building 1/36 upper B-Sand 1,1,1-TCA plume is much smaller in lateral extent, contains lower concentrations than the TCE and 1,1-DCE plumes, and the areas of elevated VOCs are more localized near the suspected source areas.

Elevated concentrations of 1,1,1-TCA in the lower B-Sand (Figure 23) are limited to the vicinity of DDS-1-2 making the size of this plume smaller than that indicated for the upper B-Sand. However, the reported concentration of 22,000 µg/l is greater that that observed in the upper B-Sand.

Middle Bellflower C-Sand 1,1,1-TCA exceeds 10,000 µg/ at DDS-1-2 (Figure 24). 1,1,1-TCA was greater than 1,000 µg/l within the vicinity of multi-depth sample location DDS-1-4. As with TCE and 1,1-DCE, the presence of the elevated 1,1,1-TCA at DDS-1-4 is dissimilar to both the upper and lower B-Sands. Again, this may be attributed to heterogeneous lithologies, and/or local differences in historical groundwater flow direction between the sands.

Given the aerial extent of 1,1-DCE impacts and the comparatively small aerial extent of 1,1,1-TCA impacts, it appears that the abiotic degradation of 1,1,1-TCA to 1,1-DCE is reasonably fast and has prevented the growth of the 1,1,1-TCA plume.

Toluene

Toluene concentrations in the upper B-Sand exceed 10,000 µg/l within two regions of the north-to-south oriented Building 1/36 plume (Figure 25). These regions are in the vicinity of WCC-3S and DDS-1-2, and a second region includes DDS-1-7 and DDS-1-14. The overall distribution of toluene in the B-sand is most similar to that of 1,1,1-TCA discussed above.

Toluene in the C-Sand exceeds 10,000 µg/ at DDS-1-2 and DDS-1-4 (Figure 26). Toluene is greater than 1,000 µg/l within the vicinity of multi-depth sample locations DDS-1-7 and DDS-1-14. The location of the elevated toluene concentration at DDS-1-4 is dissimilar to both the upper and lower B-Sand. This trend was observed for the chlorinated VOCs in the Building 1/36 plume and has been attributed to heterogeneous lithologies, and/or local differences in historical groundwater flow direction between the sands.

2-Butanone (MEK)

2-Butanone (MEK) is present at elevated concentrations exceeding 10,000 µg/l in upper B-Sand groundwater samples collected within a north-to-south oriented area including DDS-1-2, TMW-2, DDS-1-7, and DDS-1-14 (Figure 27). The MEK plume in the B-Sand is characterized by steep concentration gradients.

MEK in the C-Sand exceeds 10,000 µg/l at DDS-1-2 and DDS-1-4 (Figure 28). MEK is greater than 1,000 µg/l within the vicinity of multi-depth sample location DDS-1-14. Again, the location of the elevated toluene concentration at DDS-1-4 is dissimilar to both the upper and lower B-Sand. This trend may be attributed to heterogeneous lithologies, or local differences in groundwater flow direction between the sands.

Additional compounds

Hexavalent chromium has been detected in Building 1/36 area at concentrations up to 0.027 mg/l based on groundwater samples collected during January and February 2001 (Appendix E).

Cis-1,2-DCE has been detected in the Building 1/36 groundwater plume at concentrations up to 660 µg/l (Table 6). The presence of cis-1,2-DCE in the Building 1/36 area suggests that TCE is naturally biodegrading.

Oxidation reduction potential (ORP) data was recorded for groundwater samples collected during January and February 2001. ORP readings ranged from –187 mV (WCC-3S) to 145 mV (WCC-5S) in the Building 1/36 area. The lowest readings were recorded in the source area of the plume, suggesting biotransformation is occurring in the Building 1/36 source area.

4.2.1.3 Contaminant Fate and Transport

A comparison of the observed VOC plume extent to a predicted migration was performed to evaluate if advection could reasonably account for the observed groundwater impacts in the Building 1/36 area. The comparison assumed that VOCs could have been introduced into groundwater as much as 50 years or more before present and that the compounds migrated at the groundwater flow velocity. The TCE groundwater plumes were used for the comparison because they exhibited the greatest extent. The TCE plume extent was defined generally by the 100 µg/l concentration contour.

Groundwater flow in the Middle Bellflower B-Sand is principally to the south and the horizontal flow velocity is estimated to range from less than 5 to about 20 feet per year. The trends of groundwater plumes in the B-Sand are oriented in this principal flow direction. Groundwater flow is primarily responsible for the advective transport of VOCs; therefore, the groundwater velocity can be used as a conservative estimate of the VOC migration rate.

The lateral extent of the Building 1/36 TCE groundwater plume is indicated to be in excess of 1,000 feet (Figures 13 through 15). This includes the portion of the plume that extends from the suspected source area in the vicinity of Building 36 to the suspected source area in the southeast portion of Building 1, a distance of approximately 600 feet (Figure 12). The extent of the portion of the Building 1/36 TCE groundwater plume downgradient from the southern suspected source area would be on the

order of 500 to 750 feet. Migration of a groundwater plume of this length within a 50-year time frame would require velocities on the order of 10 to 15 feet per year. These velocities are within the range estimated from on-site hydraulic test data.

VOCs are sometimes observed to migrate at rates less than the groundwater velocity due to adsorption and dispersion. Site-specific retardation values of VOCs have not been derived for the Building 1/36 TCE groundwater plume. However, VOC migration rates as little as 75 percent of the groundwater flow velocity could reasonably account for the plume extent.

The concentrations of TCE detected in the Building 1/36 groundwater plume (much less than the solubility of 1,100,000 µg/l), in conjunction with the lack of observed free product suggest that dense non-aqueous phase liquid (DNAPL) is not present.

Biological and chemical degradation of the VOCs in the Building 1/36 groundwater plume are also indicated to be occurring. 1,1,1-TCA appears to be fairly rapidly degrading based on the elevated concentrations of 1,1-DCE in the source areas (Figures 18 through 21) and the limited migration of 1,1,1-TCA from the two suspected source areas (Figures 22 through 24). The presence of cis-1,2-DCE suggests that biotransformation of TCE is occurring. Water chemistry data including DO and ORP also support the conclusion that natural degradation processes are ongoing. The limited extent of the toluene and 2-butanone groundwater plumes also suggest biotransformation of these compounds.

4.2.1.4 Remedial Action

Soil and groundwater remedial actions are currently in progress in the Building 1/36 source area.

Source-area soil impacts are being addressed through soil vapor extraction (SVE) treatment. An extended-duration SVE pilot test was implemented in June of 2001 and operated through March of 2002. The pilot system was removed to facilitate Site demolition and grading activities. An interim full-scale SVE system including 43 extraction wells was installed in May of 2002 and was operated for one month. The SVE system is currently shut-down for modifications to its operational controls. System re-start is scheduled for the Winter 2002. To date, the pilot and interim full-scale SVE systems have removed over 9,100 pounds of VOCs from the subsurface.

Source-area groundwater VOC impacts in the Bellflower Aquitard (B-Sand and C-Sand) will be addressed through an in-situ enhanced biodegradation program. This is based on groundwater monitoring evidence that biotransformation of VOCs is currently occurring, however at a reduced rate due to a lack of nutrients. A work plan for the implementation of in-situ enhanced biodegradation was submitted to the LARWQCB in May 2002 and is currently in review. Implementation will be initiated upon LARWQCB work plan approval and issuance of a Waste Discharge Requirement (WDR) permit.

4.2.2 Building 2 Groundwater Plume

The second general area of elevated primary and secondary VOCs in groundwater generally includes the northwest portion of Building 2 and extends south and southwest to the south-central portion of Building 2. This area of elevated groundwater impacts has been designated the Building 2 area (Figure 13).

4.2.2.1 Suspected source(s)

The primary suspected source areas for elevated groundwater impacts in the Building 2 plume are soil impact areas apparently related to former metal finishing processes, and releases from one or more wastewater clarifiers. The highest concentrations of VOCs in groundwater within the Building 2 plume are present in this general area. Figure 12 illustrates the general location of TCE impacts in soil above the water table (50 feet bgs).

4.2.2.2 Primary and Secondary VOCs

Based on the concentrations of VOCs identified in groundwater samples collected from monitoring wells and the multi-depth sampling program, the primary VOC identified in the Building 2 groundwater plume area is TCE and the secondary VOCs are 1,1-DCE and chloroform (Appendix E).

4.2.2.3 Concentrations/Extent of Impacts

The primary and secondary VOC concentrations and the extent of groundwater impacts within the Building 2 area have been assessed based on groundwater samples from 7 monitoring wells and 83 multi-depth Simulprobe samples. Isoconcentration contours are presented for each primary and secondary VOCs identified in the Building 2 area illustrating the concentration distributions and the lateral extent of groundwater impacts (Figures 13 through 15, 18 through 20, and 29 through 31).

Vertical distributions of primary and secondary VOC concentrations and the vertical extent of groundwater impacts are illustrated by cross sections and by individual isoconcentration contours for the Middle Bellflower Sand units. Figures 16 and 17 illustrate the vertical distribution of TCE, the primary VOC in the Building 2 area.

The overall shape of the primary and secondary VOC plumes appears consistent with the known soil source areas and predominant groundwater flow direction. Lateral migration of VOCs in Middle Bellflower Sand within the Building 2 plume area appears to be towards the southeast. In particular, elevated concentration areas of primary and secondary VOCs in groundwater appear to migrate progressively southeast with depth. The overall lateral extent of the VOC plumes, particularly TCE in the C-Sand, are similar in size, but at lower overall concentrations and southeast of the suspected source areas.

TCE

TCE in the Middle Bellflower B-Sand within the Building 2 groundwater plume exceeded concentrations of 10,000 µg/l in the vicinity of sample location DDS-2-5A (Figure 13). A north-to-south oriented region of elevated TCE (greater than 5,000 µg/l) is centered on DDS-2-5A. This elevated TCE portion of the plume is indicated to extend approximately 750 feet from the vicinity of DDS-S-7 on the north to the vicinity of DDS-2-11 on the south and includes DDS-2-5 and DDS-2-8. The upper B-Sand TCE plume appears to merge with the southern portion of the Building 1/36 plume in the central portion of Building 2.

TCE concentrations in the lower B-Sand exceed 1,000 µg/l in the vicinity of DDS-2-5 and in a broad region including DDS-2-9 on the north extending to DDS-2-15 on the south (Figure 14). The geometry of the lower B-Sand plume is significantly different than the upper B-Sand. The area of concentrations exceeding 1,000 µg/l is further southeast in the lower B-Sand. The greatest TCE concentration in the lower B-Sand is observed at DDS-2-9 where elevated TCE was not detected in the upper B-Sand. A southeast shift in the plume with depth was also noted for VOCs in the northern portion of the Building 1/36 plume. This may be attributed to heterogeneous lithology or local differences in groundwater flow with respect to depth in the Middle Bellflower B-Sand. As with the upper B-Sand, the lower B-Sand groundwater plume merges with the southern portion of the Building 1/36 plume in the central portion of Building 2.

The distribution of TCE in the Middle Bellflower C-Sand within the Building 2 plume differs significantly from the B-Sand (Figure 15). Concentrations exceed 5,000 µg/l in the vicinity of DDS-2-26. The area of elevated concentrations appears to be southeast of that identified in the B-Sand. This shift in concentrations to the southeast with depth is attributed to heterogeneous lithologies, or local differences in groundwater flow direction between the sands where the plume appears to "step-down" into the B-Sand.

The vertical distribution of TCE in the Middle Bellflower Sand within the Building 2 plume is illustrated by a northwest to southeast cross section oriented along the axis of the upper B-Sand plume (Figure 16). The distribution of the elevated TCE in the C-Sand beneath the southeastern portion of Building 2 is illustrated on Figure 17.

Water quality hydrographs indicate that overall, concentrations of TCE in the Building 2 plume have generally decreased over time (Appendix F).

1,1-DCE

1,1-DCE is not present at elevated concentrations in the Building 2 groundwater plume (Figures 18 through 21). Two regions in the upper B-Sand are indicated to contain 1,1-DCE concentrations exceeding 100 µg/l in the vicinity of DDS-2-2 and DDS-2-7, and in the an area including DDS-2-6A, TMW-05, DDS-2-12, DDS-2-11 and DDS-2-14. 1,1-DCE concentrations are less than 100 µg/l in the lower B-Sand and C-Sand.

Since 1,1-DCE is typically the result of 1,1,1-TCA degradation and no elevated concentrations of 1,1,1-TCA were detected, it is likely that the 1,1,1-TCA degraded fairly rapidly to 1,1,-DCE without migration.

Chloroform

Concentrations of chloroform have been detected in the southern portion of the Site (Figures 29 through 31). Upper B-Sand chloroform concentrations exceed 1,000 µg/l in an area including DDS-2-14, DDS-2-16A, TMW-12, DDS-2-24 and XMW-09. The highest concentrations are in the southernmost sampling locations and decrease to the north, indicating the off-site source to the south (Figure 29)

Chloroform in the lower B-Sand exceeds 1,000 µg/l in the vicinity of DDS-2-24 and in the vicinity of DDS-2-29. Both these regions are located at the southern margin of the Site. As with the upper B-Sand, the highest lower B-Sand concentration in the south suggests the off-site source.

C-Sand groundwater concentrations of chloroform exceeded 100 µg/l in the southern portion of the Site. The concentrations of chloroform decrease with depth from the upper B-Sand to the C-Sand, and the areal extent of the chloroform plume also decreases.

Additional compounds

Chlorobenzene was detected in the southern portion of the Building 2 plume area at concentrations exceeding 5,000 µg/l (DDS-2-22, DDS-2-23, and DDS-2-29). Significant concentrations of chlorobenzene were not detected in other areas of the Site, therefore, chlorobenzene is suspected to be from off-site sources to the south.

Hexavalent chromium has been detected in Building 2 area at concentrations up to 0.037 mg/l (TMW-3) based on groundwater samples collected during January and February 2001 (Appendix E).

DO and ORP data was recorded for groundwater samples collected during January and February 2001. ORP readings ranged from 95 mV (TMW-4) to 139 mV (TMW-5) and DO readings ranged from 6.67 mg/l (TMW-4) to 9.55 mg/l (TMW-5) in the Building 2 area. Lower readings were recorded in the

vicinity of the source area of the plume, suggesting biotransformation of VOCs is occurring in the Building 2 source area.

4.2.2.4 Contaminant Fate and Transport

As with the Building 1/36 groundwater plume, a comparison of the observed Building 2 VOC plume extent to a predicted migration was performed. This was conducted to evaluate if advection could reasonably account for the mechanism responsible for the observed groundwater impacts. The comparison assumed that VOCs could have been introduced into groundwater as much as 50 years or more before present and that the compounds migrated at the groundwater flow velocity. The TCE groundwater plume was used for the comparison because they exhibited the greatest extent. The TCE plume extent was generally defined by the 100 µg/l concentration contour.

Groundwater flow in the Middle Bellflower B-Sand is principally to the southeast and the horizontal flow velocity is estimated to range from less than 5 to about 20 feet per year. The trends of groundwater plumes in the B-Sand are oriented in this principal flow direction. Groundwater flow is primarily responsible for the advective transport of VOCs; therefore, the groundwater velocity was used as a conservative estimate of the VOC migration rate.

The horizontal extent of the Building 2 TCE groundwater plume appears to be on the order of 1,400 feet in the B-Sand and 1,600 feet in the C-Sand (Figures 13 through 15). These extents include those portions of the plumes present beneath Building 2. Because it is suspected that multiple sources are present in Building 2, the extent of the portion of the groundwater plume in the south central portion of the building (near DDS-2-11) was assumed to represent the downgradient extent. Resulting plume lengths are on the order of 800 and 1,000 feet, respectively for the B-Sand and C-Sand. Migration of a groundwater plume of this length within a 50-year time frame would require velocities on the order of 15 to 20 feet per year. These velocities are within the range estimated from on-site hydraulic test data.

VOCs are sometimes observed to migrate at rates less than the groundwater velocity due to adsorption. Site-specific retardation values of VOCs have not been derived for the Building 2 TCE groundwater plume. However, VOC migration rates as little as 75 percent of the groundwater flow velocity could reasonably account for the plume extent in the B-Sand. Retardation can not be accounted in the extent of the C-Sand plume. Groundwater velocities have not been specifically determined for the C-Sand, however, this evaluation suggests that the rate of groundwater velocities in the C-Sand may be somewhat greater than the B-Sand.

The concentrations of TCE detected in the Building 2 groundwater plume (much less than the solubility of 1,100,000 µg/l), in conjunction with the lack of observed free product, suggest that DNAPL is not present.

Biological and chemical degradation of the VOCs in the Building 2 groundwater plume are also indicated to be occurring. The presence of cis-1,2-DCE suggests that biotransformation of TCE may be occurring in the Building 2 groundwater plume. Water chemistry data including DO and ORP suggest that natural degradation is present, although at a rate lower than those observed in the Building 1/36 source area.

4.2.2.5 Remedial Action

Soil and groundwater remedial actions are currently in progress in the Building 2 source area.

Source-area soil impacts are being addressed through SVE treatment. An extended-duration SVE pilot test was implemented in November of 2001. To date, the extended-duration pilot SVE system has removed over 2,600 pounds of VOCs from the subsurface.

Source-area groundwater VOC impacts in the Bellflower Aquitard (B-Sand and C-Sand) will be addressed through an in-situ enhanced biodegradation program. This is based on groundwater monitoring evidence that biotransformation of VOCs is currently occurring, however at a reduced rate due to a lack of nutrients. A work plan for the implementation of in-situ enhanced biodegradation was submitted to the LARWQCB in 2002 and was approved on May 17, 2002. Implementation is currently awaiting the LARWQCB issuance of a WDR permit. Only one combined WDR permit will be sought for both the Building 1/36 and Building 2 in-situ enhanced biodegradation activities at the Site.

5.0 SUMMARY AND CONCLUSIONS

The groundwater conditions of the Bellflower Aquitard beneath the Site have been assessed including the Site-specific hydrogeologic units, direction of groundwater flow, the chemical quality of groundwater, the potential source areas, and the lateral and vertical extent and magnitude of groundwater quality impacts.

5.1 Hydrogeology

The Site is located on the Torrance Plain within the West Coast Basin of the greater Los Angeles Basin. The uppermost hydrogeologic units underlying the Site are the Lakewood Formation, including the Bellflower Aquitard and the Gage Aquifer. Subsurface Site assessments have been focused on the relatively more permeable sands within the Bellflower Aquitard. The units of the Bellflower Aquitard identified beneath the Site are, in descending order, the Upper Bellflower Aquitard (a predominately low-permeability, fine-grained unit), the Middle Bellflower Sand, and the Lower Bellflower Aquitard (a predominately low-permeability, fine-grained unit). The Middle Bellflower Sand is further subdivided into the Middle Bellflower B-Sand, the Middle Bellflower Mud (predominately low-permeability and fine-grained), and the Middle Bellflower C-Sand. The combined Middle Bellflower Sand is on the order of 40 feet thick.

The presence of groundwater at the Site, and the direction flow have been principally defined on the basis of water level measurements at monitoring wells. The uppermost, saturated, relatively permeable unit beneath the Site is the Middle Bellflower B-Sand. Groundwater is present at an elevation between approximately 12 to 15 feet below MSL (approximately 65 feet bgs) in the B-Sand. The hydraulic gradient is approximately 0.001 feet per foot. Water levels in the B-Sand have increased on the order of 8.5 feet at the Site since monitoring was initiated during 1987. Historically, water levels were reported to have been 40 feet lower in the mid-1940s through the mid-1950s because of pumping wells in the Site vicinity. The lower water levels and a generally northeasterly geologic structural trend could have contributed to a north-northeasterly groundwater flow direction in the Site vicinity in the past.

Groundwater flow in the Middle Bellflower B-Sand is principally to the south and the horizontal flow velocity is estimated to range from less than 5 to about 20 feet per year. Groundwater flow in the Middle Bellflower C-Sand is indicated to be south to southwest. The vertical component of groundwater flow in the Middle Bellflower Sand does not appear to be significant, but a slight downward vertical gradient has been observed.

The Site is surrounded by several properties with documented groundwater impacts which have migrated onto the Site because of regional groundwater flow direction. The primary VOCs at Del Amo

that extend on to the Site are benzene and TCE. The primary VOCs at Montrose that extend on to the Site are chloroform and chlorobenzene. The primary VOC at ILM that extends on to the Site is TCE.

5.2 Investigation Summary

The soil and groundwater at the Site have been investigated since 1987. Over 8,000 soil samples, 43 groundwater monitoring wells, and 44 depth discrete groundwater sampling locations have been drilled and sampled at the Site. Some of the groundwater monitoring wells have been sampled up to 37 times. Two primary source areas, the Building 1/36 and Building 2 areas, were identified and a large percentage of the soil sampling and groundwater investigation focused on these areas.

5.3 Groundwater Quality

The chemical quality of groundwater and water quality impacts beneath the Site in the Bellflower Aquitard has been defined based on groundwater samples collected from monitoring wells, including MNA data, and multi-depth (Simulprobe) sampling. Principally laboratory analyses have been conducted for VOCs and samples have been collected from the upper B-Sand.

TCE was the most prevalent compound detected at the highest concentrations and in the greatest number of samples. Elevated primary VOC concentrations have been identified in the Building 1/36 and the Building 2 source areas. These areas have been the targets for detailed groundwater assessment at the Site.

The following four VOCs were also detected in elevated concentrations and are considered the secondary VOCs:

- 1,1-DCE,
- cis-1,2-DCE,
- 1,1,1-TCA, and
- 2-Butanone (or MEK).

The secondary Site-Wide groundwater VOCs have generally been detected within the primary Site-Wide groundwater VOC plumes.

Hexavalent chromium was also detected in groundwater monitoring wells (installed for the Former C-6 Facility) up to 0.037 mg/l. Based on the results from the Site wells, hexavalent chromium concentrations were not detected above the MCL for total chromium (0.050 mg/l). As a result, hexavalent chromium is not considered to be a primary or secondary compound at the Site. However, two wells installed along the perimeter of the Site (DAC-P1 [0.590 mg/l] and XMW-19 [0.055 mg/l]) to assess the hexavalent chromium plumes originating from the ILM and Montrose facilities were reported to have concentrations of hexavalent chromium in excess of the total chromium MCL.

Elevated concentrations of primary and secondary VOCs have been identified in two general areas of the Site, the Building 1/36 area and the Building 2 area. The primary suspected source areas for elevated groundwater impacts in the Building 1/36 plume are soil impact areas identified beneath Building 36, the northeast portion of Building 1, and the southeast portion of Building 1. The primary suspected source areas for elevated groundwater impacts in the Building 2 plume are soil impact areas identified in the northwest portion of Building 2.

Building 1/36 Area

The primary and secondary VOC concentrations and the extent of groundwater impacts within the Building 1/36 Area in the Bellflower Aquitard have been assessed based on groundwater samples from 16 monitoring wells and 41 multi-depth Simulprobe samples. The lateral limits of the plumes in the Building 1/36 plume have been delineated and the areas of elevated primary and secondary VOCs are currently indicated to be confined to the Site. The overall shape of the plumes in the Building 1/36 area appears consistent with the known soil source areas and the predominant groundwater flow direction to the south. The presence of VOC degradation products (cis-1,2-DCE and 1,1-DCE), low readings of DO (0.20 mg/l), and low readings of ORP (-187 mV) indicate that biotransformation of VOCs is occurring in the Building 1/36 plume.

Building 2 Area

The extent of groundwater impacts beneath the Building 2 area in the Bellflower Aquitard have been assessed based on groundwater samples from 7 monitoring wells and 83 multi-depth Simulprobe samples. The lateral limits of the primary and secondary VOC plumes in the Building 2 plume area have been delineated and the areas of elevated primary and secondary VOCs are currently indicated to be confined to the Site. The overall shape of the plumes appears consistent with the known soil source areas and predominant groundwater flow direction. The location of elevated concentrations of primary and secondary VOCs in the C-Sand relative to the B-Sand indicates that migration is to the southeast with respect to depth. DO and ORP data do not suggest strongly reducing conditions. Depressed DO and ORP values in the source area suggest that biotransformation of VOCs is occurring in the Building 2 plume, although at a lower rate than the Building 1/36 plume.

5.4 Conceptual Model

A conceptual model for contaminant transport in groundwater at the Site has been developed based on the data derived from the various groundwater assessment programs performed at the Site and the anticipated fate and transport of the primary and secondary VOCs. The conceptual model has been developed based on the types of sources, the physical and chemical characteristics of the chemicals present, and the anticipated fate and transport of the chemicals within the impacted media. This

groundwater assessment only addresses the Bellflower Aquitard, therefore the conceptual model focuses on the movement of groundwater and the primary and secondary VOCs within the Bellflower Aquitard.

The primary mechanism of fate and transport is groundwater flow. Key components of groundwater flow and fate and transport include:

- Horizontal groundwater flow is the predominant transport mechanism. This is supported by good correlation of VOC plume shape with the predominant horizontal groundwater flow direction.

- Dispersion and diffusion are secondary but important transport mechanisms as evidenced by the increase in the lateral extent of the VOC plumes with respect to distance downgradient from the suspected sources. Converging horizontal groundwater flow on the Site has likely minimized the effects of dispersion and diffusion.

- Downward vertical migration appears to be the primary mechanism of impacts penetrating into the C-Sand due to the slight vertical component of groundwater flow. The Middle Bellflower Mud reduces this downward migration in those areas where it is present. Localized differences in permeability of the subsurface materials plus localized and seasonal differences in the direction of groundwater movement result in deviations in the plume geometry. In areas where the Middle Bellflower Mud has higher permeability, the primary and secondary VOC plumes appears to "step down" into the C-Sand.

- The calculated groundwater flow rate (5 to 20 feet per year) is due to the overall low permeability of the subsurface materials and shallow hydraulic gradient. This is consistent with the length of the groundwater plumes, considering the time since Site activity began.

- Water chemistry data including DO and ORP analytical results indicate that the overall rate of primary and secondary VOC migration may be further retarded by natural degradation processes. This is supported by the occurrence of the degradation daughter products cis-1,2-DCE and 1,1-DCE in the TCE and 1,1,1-TCA plume areas, respectively. The limited size of the groundwater plumes and the steep concentration gradients observed for toluene and 2-butonane with respect to the other primary and secondary VOCs also indicate that these compounds may be more actively degrading. Depressed DO and ORP values within the VOC source areas indicate reducing conditions and suggest the VOCs are undergoing biotransformation.

- The presence of chlorobenzene in groundwater along the southern Site boundary may be enhancing the rate of primary and secondary VOC degradation and therefore assisting in maintaining the downgradient limits of the plumes within the Site boundary.

5.5 Conclusions

The Site has undergone an iterative and comprehensive groundwater assessment program over the past 16 years to evaluate the nature and extent of groundwater impacts in the Bellflower Aquitard. This assessment program was recently completed through the implementation of the source-area groundwater reconnaissance program for the purposes of completing a human-health risk assessment in Parcel C and performing remedial evaluations where necessary. The following conclusions can be drawn from the completion of this groundwater assessment program:

- Site-wide groundwater conditions in the Bellflower Aquitard have been adequately characterized.

- Groundwater in the Bellflower Aquitard is not suitable for use and is not produced for domestic, industrial, or agricultural purposes.

- The nearest groundwater production well to the Site is over ½ mile away and draws water from the Silverado Aquifer at a depth of over 500 feet below ground surface.

- The primary VOC found in groundwater at the Site is TCE and the secondary VOCs are 1,1-DCE, 1,1,1-TCA, 2-butanone, and toluene. These VOCs are found at concentrations that exceed drinking water standards.

- The groundwater primary and secondary VOC impact source areas have been delineated. The primary source areas are the Building 1/36 area and the Building 2 area. Good correlation exists between the soil impact areas and the groundwater impact source areas.

- Groundwater flow on the Site is predominantly horizontal, however a mild downward gradient (approximately ranges from 0.002 to –0.009 ft./ft) is also present and therefore minor downward flow likely occurs.

- Groundwater flow appears to be the principal mechanism of primary and secondary VOC fate and transport based on the estimated groundwater velocity, groundwater flow direction, and the plume lengths.

- Groundwater impacts are primarily located in the upper portion of the Bellflower Aquitard (B-Sand).

- Fine-grained units such as the Middle Bellflower Mud appear to constrain the distribution of the primary and secondary VOCs in the Bellflower Aquitard. Areas where the Middle Bellflower Mud thins or is coarser-grained, the plumes appear to "step down" into the C-Sand.

- Groundwater impacts appear to be primarily contained on the Site. This is attributed to low groundwater flow rates, converging groundwater flow, and biotransformation of VOCs.

- Good correlation exists between the groundwater flow patterns and the distribution of primary and secondary VOCs in groundwater at the Site.

- Natural attenuation monitoring suggests that the primary and secondary VOCs are being biotically or abiotically transformed. This evidence is particularly present in the source areas.

- Further, downgradient migration of the primary and secondary VOC plumes appears to be limited due to enhanced degradation assisted by the presence of chlorobenzene from off-site sources.

- No human health risk exists associated with upward migration of VOC vapors, based on the Site-Wide SRA (Haley & Aldrich, Inc., 2002).

Based on these conclusions, groundwater has been adequately assessed for resource impact and remedial evaluation purposes as applicable.

6.0 REFERENCES

California Department of Water Resources, 1961. Planned Utilization of the Ground Water Basins of the Coastal Plain of Los Angeles County, Appendix A, Ground Water Geology, CDWR, Bulletin 104.

California Department of Water Resources, 1999. WaterMaster Service in the West Coast Basin, Los Angeles County, July 1, 1998-June 30, 1999. September 1999.

Camp, Dresser, & McKee, 1991. Phase I Environmental Assessment of the Douglas Aircraft Company C-6 Facility, Parking Lot and Tool Storage Yard, Los Angeles, California. June 13, 1991.

Dames & Moore, 1998. Final Groundwater Remedial Investigation Report, Del Amo Study Area, Los Angeles, California. For Shell Oil Company and The Dow Chemical Company. May 15, 1998.

Haley & Aldrich, 2001. Groundwater Monitoring Report-Annual Event, January/February, 2001. Boeing Realty Corporation, Former C-6 Facility, Los Angeles, California. June 20, 2001.

Haley & Aldrich, 2002. Soil Investigation, Soil Remediation, and Screening Level Risk Assessment Report, Former C-6 Facility, Los Angeles, California. March 2002.

Hargis & Associates, 2002. Personal communication by Beth Breitenbach on October 17, 2002.

Kennedy Jenks Consultants, 2000. Groundwater Status Report, Volumes I and II, Former C-6 Facility, Los Angeles, California. December 2000.

Poland, J.F., Garrett, A.A., and Sinnott, A., 1959, "Geology, Hydrogeology, and Chemical Character of the Ground Waters in the Torrance -Santa Monica, California" USGS Water Supply Paper 1461, U.S. Government Printing Office

Richard C. Slade & Associates, 1998. Summary of Operations, Destruction of Two Water-Supply Wells, Boeing Realty Corporation C-6 Facility, Los Angeles, California. September 1998.

Richard C. Slade & Associates, 2001. Summary of Operations for the Destruction of Former Water-Supply Well No. 1 at the Former Boeing Realty Corporation C-6 Facility, 19503 South Normandie Avenue, Los Angeles, California. July 2001.

TRC, 1999. Ground Water RCRA Facility Investigation Report, Volumes I and II, Former International Light Metals Facility, Torrance, California. December, 1999.

Woodward-Clyde Consultants, 1990. Douglas Aircraft Company, Torrance (C6) Facility Phase III Groundwater and Soil Investigation Report, March 1990.

7.0 LIMITATIONS

This report was prepared by Haley & Aldrich, Inc. under the professional direction and review of the registered professionals listed on the cover page. The work described herein was conducted in accordance with generally accepted professional engineering and geologic practice. No other warranty exists, either expressed or implied.

In addition to data collected by and observations made by Haley & Aldrich personnel, this report incorporates site conditions observed and described by others as reported in records available to Haley & Aldrich as of the date of report preparation. Haley & Aldrich relied—in part—on such data collected by others in the development of interpretations about environmental conditions at the Site. The accuracy, precision, or representative nature of data originally generated by others could not be independently verified by Haley & Aldrich and would be beyond the scope of this project.

In addition, the passage of time may result in changes in site conditions, technology, or economic conditions which could alter the findings and/or recommendations of the report.